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## N-channel 600 V, 0.094 $\Omega$ typ., 28 A MDmesh™ DM2 Power MOSFET in a TO-247 package

Datasheet - production data

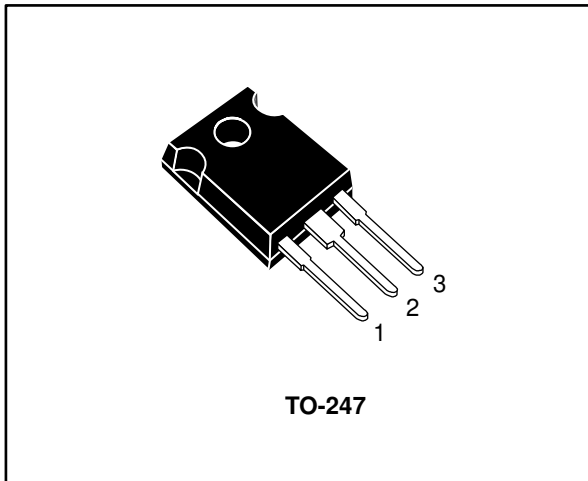
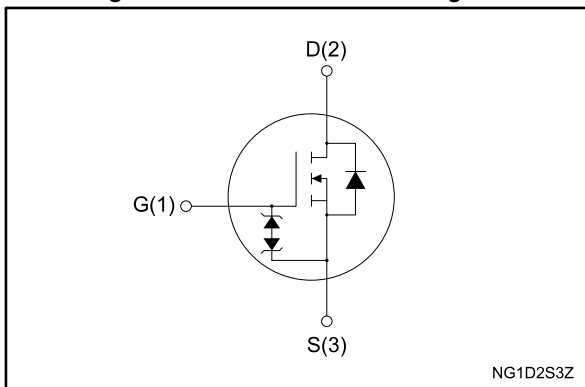


Figure 1: Internal schematic diagram



### Features

Order code	$V_{DS}$	$R_{DS(on)}$ max.	$I_D$	$P_{TOT}$
STW35N60DM2	600 V	0.110 $\Omega$	28 A	210 W

- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

### Applications

- Switching applications

### Description

This high voltage N-channel Power MOSFET is part of the MDmesh™ DM2 fast recovery diode series. It offers very low recovery charge ( $Q_{rr}$ ) and time ( $t_{rr}$ ) combined with low  $R_{DS(on)}$ , rendering it suitable for the most demanding high efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

Table 1: Device summary

Order code	Marking	Package	Packing
STW35N60DM2	35N60DM2	TO-247	Tube

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# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	±25	V
$I_D$	Drain current (continuous) at $T_{case} = 25\text{ °C}$	28	A
	Drain current (continuous) at $T_{case} = 100\text{ °C}$	17	
$I_{DM}^{(1)}$	Drain current (pulsed)	112	A
$P_{TOT}$	Total dissipation at $T_{case} = 25\text{ °C}$	210	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	50	V/ns
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	50	
$T_{stg}$	Storage temperature	-55 to 150	°C
$T_j$	Operating junction temperature		

**Notes:**

<sup>(1)</sup> Pulse width is limited by safe operating area.

<sup>(2)</sup>  $I_{SD} \leq 28\text{ A}$ ,  $di/dt=900\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$

<sup>(3)</sup>  $V_{DS} \leq 480\text{ V}$ .

**Table 3: Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case	0.6	°C/W
$R_{thj-amb}$	Thermal resistance junction-amb	50	

**Table 4: Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive	6	A
$E_{AS}^{(1)}$	Single pulse avalanche energy	650	mJ

**Notes:**

<sup>(1)</sup> starting  $T_j = 25\text{ °C}$ ,  $I_D = I_{AR}$ ,  $V_{DD} = 50\text{ V}$ .

## 2 Electrical characteristics

( $T_{\text{case}} = 25\text{ °C}$  unless otherwise specified)

**Table 5: Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$			10	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_{\text{case}} = 125\text{ °C}$			100	
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$			$\pm 5$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 14\text{ A}$		0.094	0.11	$\Omega$

**Table 6: Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ISS}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	2400	-	$\mu\text{F}$
$C_{OSS}$	Output capacitance		-	110	-	
$C_{RSS}$	Reverse transfer capacitance		-	2.8	-	
$C_{OSS\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$	-	190	-	$\mu\text{F}$
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	4.3	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 28\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 15: "Test circuit for gate charge behavior"</a> )	-	54	-	nC
$Q_{gs}$	Gate-source charge		-	14.6	-	
$Q_{gd}$	Gate-drain charge		-	24.2	-	

**Notes:**

<sup>(1)</sup>  $C_{OSS\text{ eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{OSS}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$ .

**Table 7: Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 14\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 14: "Test circuit for resistive load switching times"</a> and <a href="#">Figure 19: "Switching time waveform"</a> )	-	21.2	-	ns
$t_r$	Rise time		-	17	-	
$t_{d(off)}$	Turn-off delay time		-	68	-	
$t_f$	Fall time		-	10.7	-	



Table 8: Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		28	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		112	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0 \text{ V}$ , $I_{SD} = 28 \text{ A}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 28 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ , $V_{DD} = 60 \text{ V}$ (see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> )	-	120		ns
$Q_{rr}$	Reverse recovery charge		-	572		nC
$I_{RRM}$	Reverse recovery current		-	10.2		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 28 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ , $V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> )	-	215		ns
$Q_{rr}$	Reverse recovery charge		-	1.89		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	17.7		A

**Notes:**

<sup>(1)</sup> Pulse width is limited by safe operating area.

<sup>(2)</sup> Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

Table 9: Gate-source Zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 250 \text{ } \mu\text{A}$ , $I_D = 0 \text{ A}$	$\pm 30$	-	-	V

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.2 Electrical characteristics (curves)

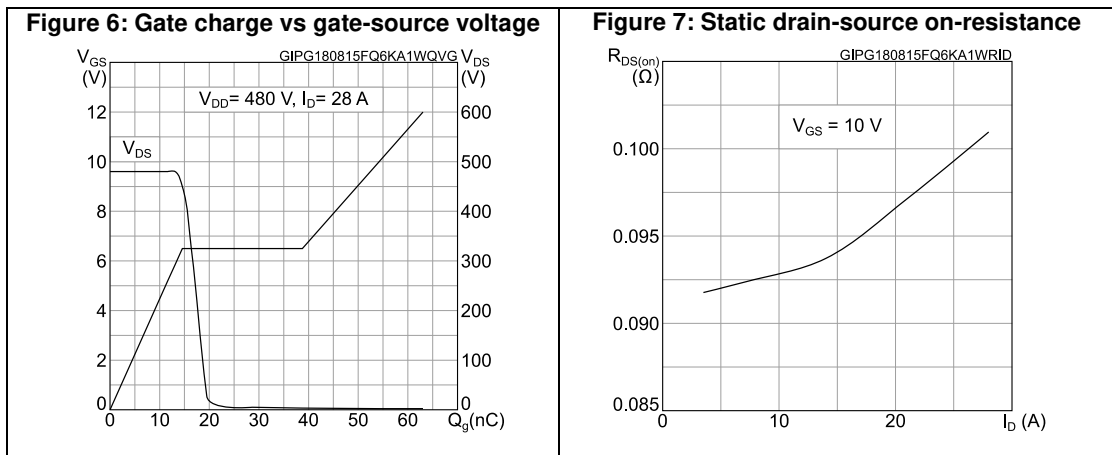
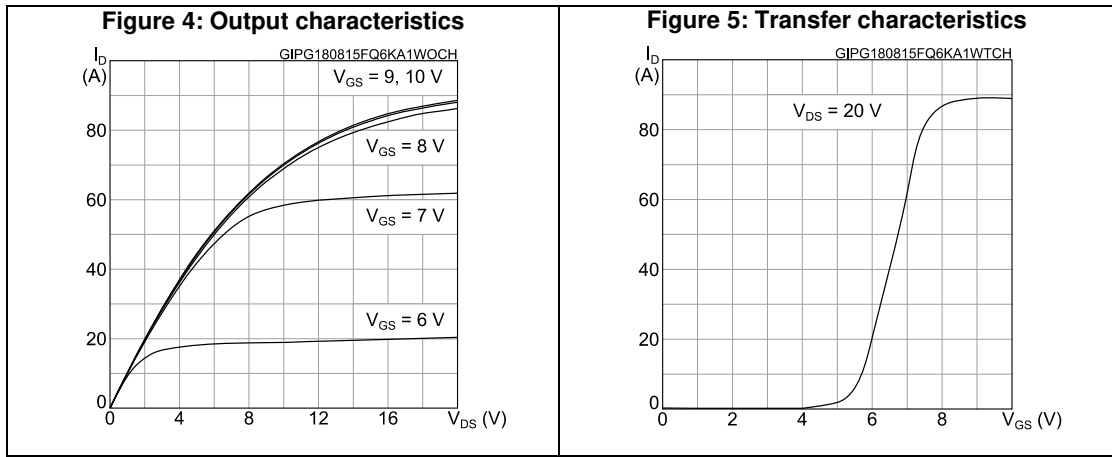
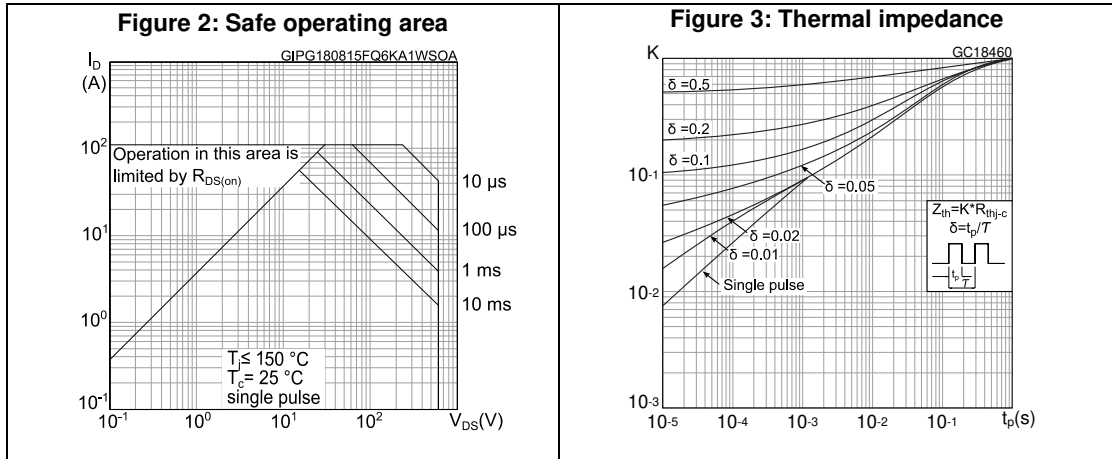


Figure 8: Capacitance variations

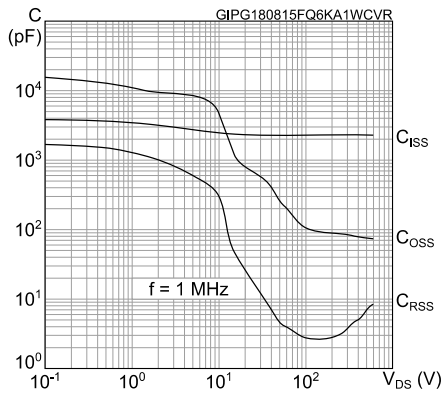


Figure 9: Normalized gate threshold voltage vs temperature

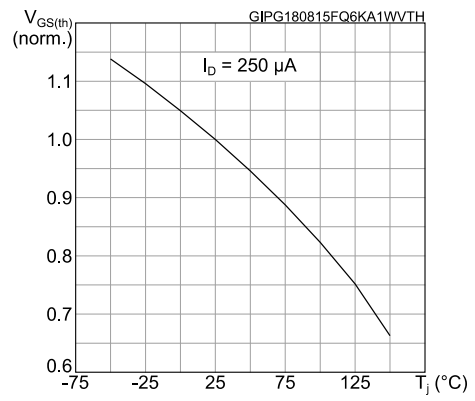


Figure 10: Normalized on-resistance vs temperature

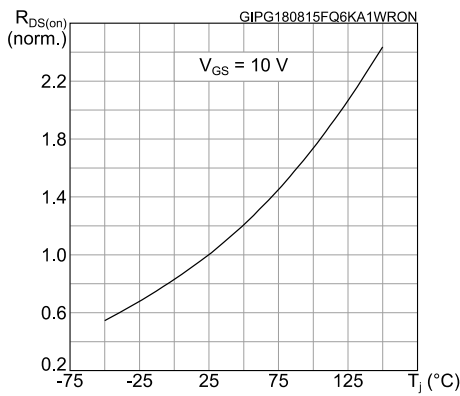


Figure 11: Normalized V(BR)DSS vs temperature

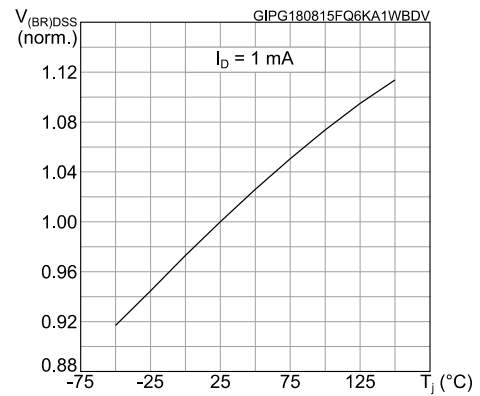


Figure 12: Output capacitance stored energy

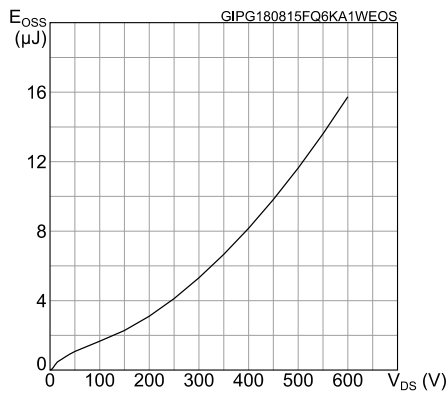
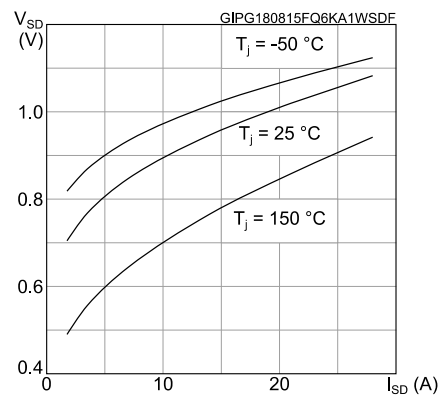


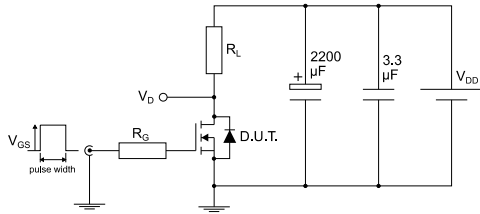
Figure 13: Source-drain diode forward characteristics





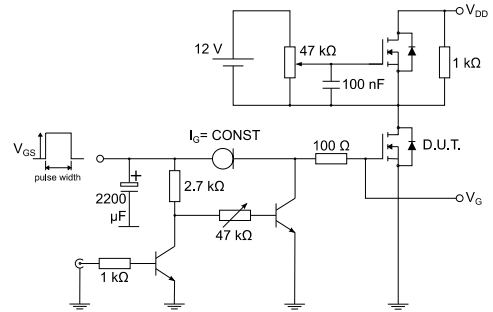
### 3 Test circuits

**Figure 14: Test circuit for resistive load switching times**



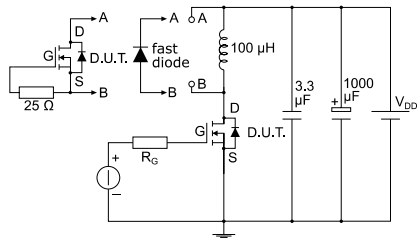
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**Figure 15: Test circuit for gate charge behavior**



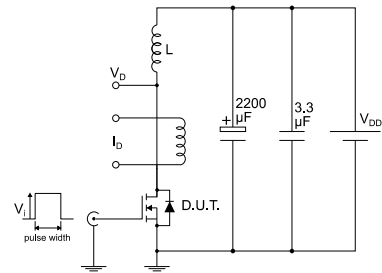
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**Figure 16: Test circuit for inductive load switching and diode recovery times**



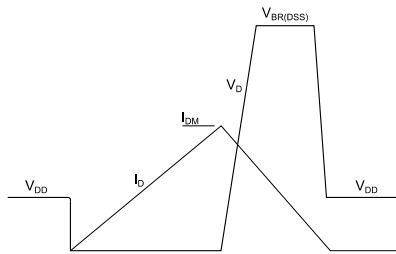
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**Figure 17: Unclamped inductive load test circuit**



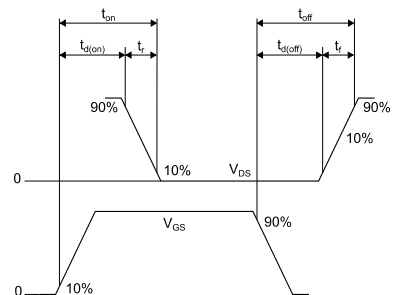
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**Figure 18: Unclamped inductive waveform**



AM01472v1

**Figure 19: Switching time waveform**



AM01473v1

## 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 4.1 TO-247 package information

Figure 20: TO-247 package outline

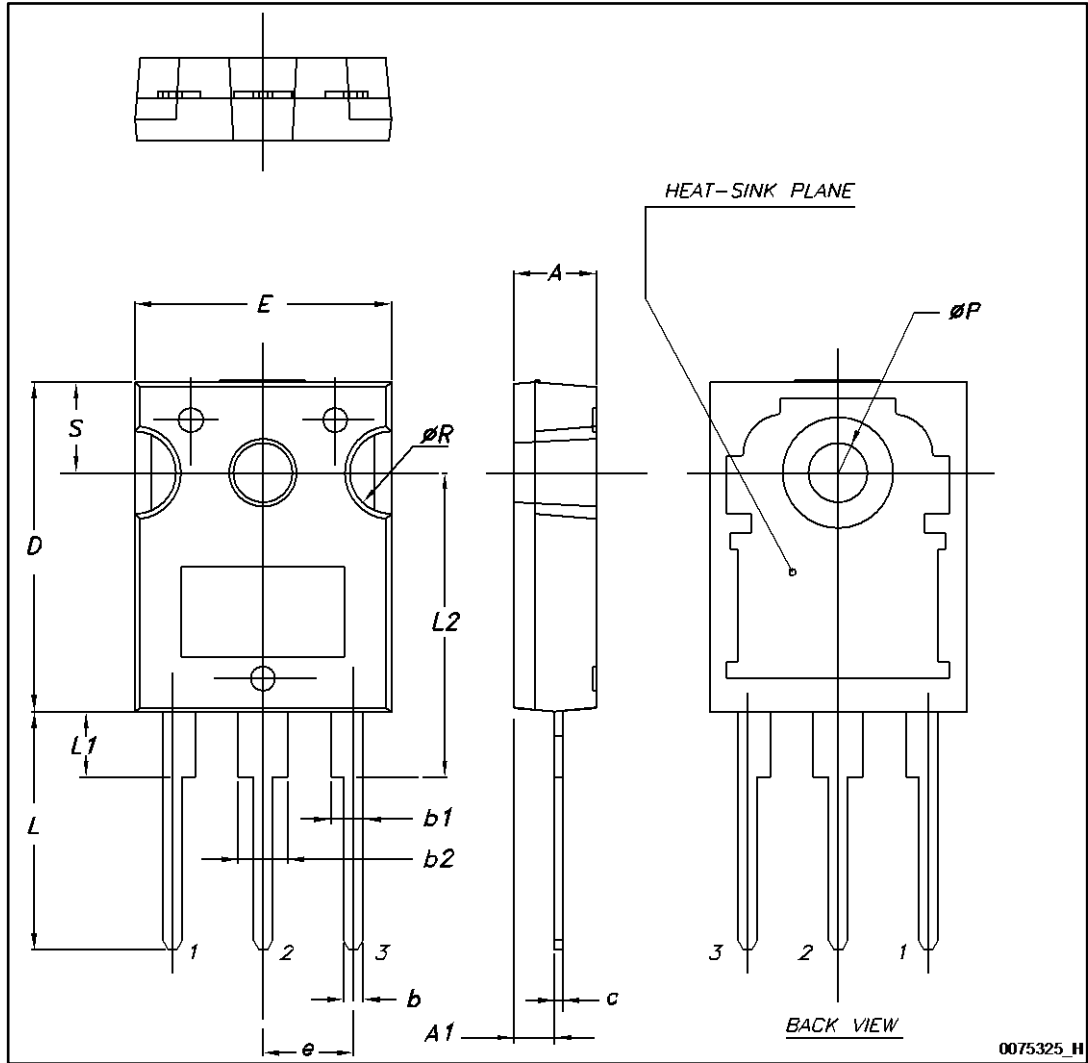


Table 10: TO-247 package mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

## 5 Revision history

Table 11: Document revision history

Date	Revision	Changes
02-Sep-2015	1	Initial version

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